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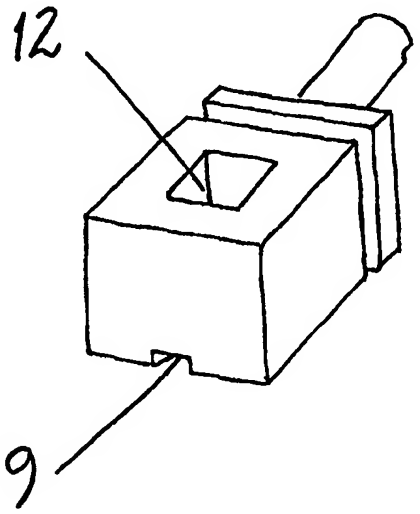
(57) Abstract

The present invention concerns a method for the production by machining of a dental restoration body for use when mending, restoring or building up a tooth or row of teeth, as well as a blank intented for the production of the dental restoration body by machining. The procedure involves that numerical information about the geometry of the desired restoration body is compared with information about the geometry of available blanks; that information about the colour of the desired restoration body is compared with information about the colour of available blanks; that the blank whose geometry most closely exceeds the geometry of the desired restoration body and whose colour most closely agrees with the colour of the desired restoration body is selected; and that the chosen blank is machined to the desired restoration body. The blank includes a part for firmly attaching the blank during machining, the firm attachment part (5), and a part intended to be machined, the machined part (7), that has a specified geometry, whereby a waist of material (8) or neck to facilitate the access of the machine tool and reduce the amount of rough machining during the production of the restoration body is arranged between the parts. In addition, the geometry of the machined part (7) is roughly pre-formed and a directional orienting reference device is arranged at a specified position on the blank. A recess (12) of specified dimensions is also arranged on one surface of the machined part (7).



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Method and blank for the production of a dental body

The present invention concerns a procedure for the production by machining of a dental restoration body for use when mending, restoring or building up a tooth or row of teeth, as well as a blank intended for the production of the dental restoration body by machining.

Numerically-controlled machine tools are today used for producing dental restoration bodies such as crowns for building up a tooth and inserts for filling a drilled-out or damaged tooth. These machine tools commonly employ what is known as CAM technology. The restoration body is built-up in a software program, and with knowledge of the geometry of a worked piece or a blank, the computer can work out a pattern of movements for a known machine tool, usually a milling or grinding tool, that by cutting away at the blank, produces the desired restoration body.

Several ceramic materials have been found to display the characteristics that are advantageous for this application. One ceramic that can be used with advantage is zirconium, ZrO_2. Blanks of zirconium ceramic can be produced in several shades of colour that resemble those of teeth and, like several other candidate ceramics, it is a hard material that is very resistant to being worn down.

To simplify the part of setting up the blank in the machine tool, and the part of describing for the software program the geometry of the blank and its spatial position when mounted in the machine tool, the blank is at present commonly a cylindrical body with a specified diameter and extension. The turning of the blank at its point of attachment is thus not of significance. Instead, what is influential regarding the position of the blank is how far it projects out from its attachment. Describing this spatial position and the geometry for a CAM system is easy.

Since different restoration bodies can vary greatly in size and shape - the largest is commonly equivalent to a tooth or row of teeth and the smallest equivalent to a small section of a tooth - the majority of machining operations involve relatively large volumes of material being cut away. The resistance to wear and the hardness of the material make the machining expensive, due, among other things, to the long machining times and the high rate of machine tool wear. The risk of machine tool breakage during machining is also considerable when the tool has a relatively small diameter in relation to how far its free working end extends out from the tool holder, e.g. a chuck.

A further problem occurs when shaping a hole or cavity when the machining takes place in a restricted area over a relatively long time. This causes the temperature of the blank in the immediate vicinity of the machining to rise, with the consequent risk crack formation.

The small dimensions and the detailed shaping of restoration bodies for dental care place just such high demands on the machine tool. The forming of shapes complementary to, for example, a hole drilled in a tooth or a tooth ground-down to accommodate a crown, requires great accuracy in the machining. An abrasive circular tool with a diameter of 1 mm can be named as an example of a tool that can be used. The small dimensions and a relatively long free projection are necessary to achieve the details in the surface structure and to gain access all around the body.

The problem of machine tool wear is especially evident when producing a crown. The underneath of a crown is provided with a cavity for accommodating a ground-down tooth or other type of attachment. Gaining access to the cavity is a machine tooling operation that is time-consuming and hard on the wear of the tool. The development of heat at prolonged, locally situated machining brings with it a significant risk of crack formation. If cracks form, the result will not be acceptable and the production has to be started afresh with a new blank.

To shape a restoration body as completely as possible, it is necessary that the body remains in the machine tool. The final step is, therefore, that the shaped section is worked loose from that part of the blank that is firmly attached to the machine tool, or that the machining continues until only a narrow strip of material is left joining the parts together. Such a thin element requires a great deal of cutting away and, in relation to its diameter, a relatively long projection of the tool, which means that there is a risk of the tool breaking.

Another problem that arises for anyone wanting to produce dental restoration bodies and intending to do this without following it up with a separate colouring step, is to differentiate blanks according to their shades of colour. This is a source of error if blanks with different shades have been mixed together. It is often difficult for the naked eye to identify a specific colour among blanks where different colours, or rather shades of colours, are mixed together.

To summarise, the problems with current blanks are: that the hardness of the blank leads to significant wear of the machine tool and prolongs the time required for the machining operation; that the cylindrical shape of the blank leads requires a large amount of rough cutting before the actual shaping can begin; and that cracks tend to form in the material when machining holes or cavities.

These problems act to raise the cost of producing restoration bodies by machining in general, and in particular when the bodies are made of hard materials such as ceramics.

The objective of the present invention is to overcome these problems and achieve a blank intended for producing dental restoration bodies by machining that permits reduced machining time and reduces the wear on the tools.

An additional objective of the invention is to achieve a blank whose characteristics can be read by a machine.

A further objective is to achieve a blank that can be stored in a magazine for mechanical/automated loading to a position for machining.

These objectives are met by a procedure and a blank that have been named above and that have the characteristics specified in the enclosed independent claims.

The objectives named above plus others, the characteristics and advantages of the invention will become apparent by the following detailed description of one preferred embodiment of the invention, which comprises one example and as such is not limiting for the extent of protection of the invention. To simplify understanding, the text includes references to the enclosed illustrations in which equivalent or similar parts have been assigned the same reference number.

Fig. 1 shows schematically a system for performing the procedure according to the present invention.

Fig. 2 shows a side view of a blank according to one embodiment of the present invention.

Fig. 3 shows an end view of the blank according to fig. 2.

Fig. 4 shows a perspective view from an angle at the front of the blank according to fig. 2.

Fig. 5 shows a further perspective view of the blank according to fig. 2.

Fig. 1 shows schematically a system for producing dental restoration bodies. The system includes a computer (not shown) for transforming geometric information about a specified restoration body and a specified blank to a pattern of movements for a specified machine tool; as well as a numerically-controlled machine tool 2 for performing the machining. It is advantageous if the tool has several axes of rotation for both the tool holder 3 and the blank holder 4.

The blank according to the present embodiment is shown schematically in figs. 2 to 4. The blank has a section for attaching firmly that includes a cylindrical part 5 intended for setting up in the machine tool. Usually the cylindrical part 5 is grasped in the traditional manner

by the holding chuck 4 for the blank in the machine tool. The centre axis of the cylindrical part thus coincides with the axis of rotation commonly present in the chuck for the blank.

The extension of the centre axis of the cylindrical part is used below as a reference when describing the other parts of the blank when it is then given the name the axis of the blank or the blank axis 6.

In contrast to the cylindrical part of the blank 5, which is standardised, the part intended for machining 7 has a roughly pre-formed geometry for different types of dental restoration bodies.

In the present embodiment, the part to be machined 7 has an essentially rectangular cross-sectional shape when seen in a section at right angles to the axis of the blank 6. The rectangular shape reduces the need for rough cutting when producing crowns, for example, in comparison with a blank with a circular cross-section. The blank is preferably available in a set of different sizes of the machined part 7 to minimise machining when producing the dental restoration body in question.

To further limit the rough cutting and to improve the access of the machine tool during machining, a thinner waist of material 8 is arranged between the cylindrical part 5 and the machined part 7. The waist has a smaller cross-sectional area at its surface than both the cylindrical part and the machined part. Its objective is to facilitate access for the tool when machining that side of the restoration body that faces the cylindrical part.

In order that the blank can be handled mechanically in a numerically-controlled machine, it is provided with means for controlling its orientation. These can include means that are complementary in relation to means arranged on a supporting device, such as, for example, a magazine for blanks, a blank holder, a transport belt for blanks or similar. It can thus be ensured that the blank, when it is located in a magazine, for example, is always oriented in the same way and that it can be collected from that point or delivered in a specified orientation. The exact position and orientation of the blank is thus known to the machine tool and to the software program that controls it.

In the present embodiment, the device for controlling orientation includes a recess 9 arranged in a specified position. The recess 9 is positioned at the blank so that when the blank is introduced into a magazine 10 with the correct orientation, the recess accommodates a projection arranged in the magazine. If, however, the blank is not orientated in the pre-determined way when it enters the magazine, the projection of the magazine will prevent the blank from entering

the magazine, when the risk of an incorrectly orientated blank is eliminated. That referred to as the human factor has been eliminated as a source of error.

In addition, the blank according to the present invention includes a collar 11 that interacts with the supporting device. The aim of the collar is to interact with the supporting device even when the machining of the body has been completed so that the machined body, with or without the shaped body, can be mechanically transported to the magazine and kept there.

In the present preferred embodiment, it has been described that the blank has a collar to be accommodated in the complementary shaped device of the magazine and a recess for guiding its orientation and interaction with a complementary device in the magazine. It is even possible to use other complementary shaped devices that achieve the same function during interaction between the blank and the magazine, for example, the recess that specifies direction can be replaced by a projection and the collar can be replaced by a groove or waist, whereby the complementary formed devices arranged in the magazine achieve the function named above.

To reduce the volume of material that has to be machined when producing a crown, the blank according to a preferred embodiment has a recess 12 arranged in the part intended for machining 7. The recess 12 is arranged on a surface parallel with the axis of the blank 6 and is essentially pyramid or cone-shaped with a centre axis arranged at right angles to the axis of the blank 6. In this way, the rough cutting that takes place prior to the machined shaping of the cavity of the crown for accommodating the ground-down stump of a tooth or other point of attachment is reduced.

The recess can even be arranged, for example, at the free end of the machined part 7, whereby an axis of symmetry for the recess or hole can coincide or be parallel with the axis of the blank 6.

For the characteristics of the blank, such as geometric dimensions, colour, material characteristics, etc., to be identifiable, the blank has a machine-readable code that corresponds to a code key. The key to the code is in turn preferably arranged in machine-readable code form, e.g. a computer file of information that can be fed into the computer system that controls the procedure and the machine tool. There is an identity code for every combination of characteristics.

According to the present embodiment, the code for the blank is arranged at the attachment part 5. The code includes a flat area 13 that extends out from the free end of the cylindrical attachment part for a known distance in towards the attachment point. In addition, the

flat section is arranged at a known distance from the axis of the blank 6 that is less than the radius of the attachment part.

By reading length and width dimensions of the area (or the axial extension of the area and the distance of the plane section from the centre axis of the attachment part) two co-ordinates are obtained that correspond to information in the code key of the characteristics of the individual blank.

According to the present embodiment, the blanks arranged in the magazine, supported by the collars and with their attachment parts extending outwards, can in this way be read by a machine and their characteristics compared with awaiting orders for working dental restoration bodies.

According to the present embodiment, the flat surface can advantageously be read using laser measurement technology. Even other remote methods of measurement or contact-based methods of measurement can be used without departing from the scope of the invention.

The code information can even be arranged on another position on the blank, e.g. be applied to the blank in the form of a bar code or a groove or a ridge, whereby the latter two examples can employ three co-ordinates (length, width and depth/height).

In addition, the flat surface named above can be given a collar and thereby be used as a stop for rotation.

During the manufacture of the blank of ceramic material, the blank is shaped and its colour is determined by chosen ingredients. Following this, the blank is baked at about 1600 °C. It is preferable that the coding takes place as early as possible, which is why a coding that can withstand the temperature of baking is desirable. A coding expressed via geometric changes of shape or combinations of such changes applied to the blank prior to the baking is one preferred solution to the problem of achieving the coding of the colour, dimensions and other characteristics of the blank as early as possible during the production of the blank.

The position of the coding is determined by how the blank is handled on the path to the blank holder in the machine tool. The code must be accessible when the reading takes place. If all the characteristics, for example, are read after the blank has been loaded into the magazine, it is important that the code is accessible for reading when the blank is located in the magazine. If, however, the code is read prior to introduction into the magazine, the coding can be positioned at another place on the blank and can be hidden when the blank is located in the magazine.

In addition, the blank can be provided with a pre-formed cut-out recess or groove at a specified position and with specified dimensions intended as an attachment point for other dental restoration bodies.

Claims

1. Procedure for the production by machining of dental restoration bodies for use when mending, restoring or building up a tooth or row of teeth c h a r a c t e r i s e d in that numerical information about the geometry of the desired restoration body is compared with information about the geometry of available blanks; that numerical information about the colour of the desired restoration body is compared with information about the colour of available blanks; that the blank whose geometry most closely exceeds the geometry of the desired restoration body and whose colour most closely agrees with the colour of the desired restoration body is selected; that the chosen blank is machined to the desired restoration body.

2. Blank for use in the procedure according to claim 1 that in one piece includes a part for firmly attaching the blank during machining, the firm attachment part (5), and a part intended to be machined, the machined part (7), whereby the machined part has a specified geometry c h a r a c t e r i s e d in that a waist of material (8) or neck is arranged between the parts to facilitate the access of the machine tool and reduce the amount of rough machining during the production of the restoration body, that the geometry of the machined part (7) is roughly pre-formed, that a directional orienting reference device is arranged at a specified position on the blank, and that a recess (12) of specified dimensions is arranged on one surface of the machined part (7).

3. Blank according to claim 2 c h a r a c t e r i s e d in that a flange (11) or collar extending radially outwards in relation to an imaginary axis of the blank (6) is arranged adjacent to the waist (8) and intended to interact with a complementary shaped device on a device for supporting the blank.

4. Blank according to claim 2 or 3 c h a r a c t e r i s e d in that the directional orienting reference device includes a guiding recess (9) arranged in a specified position on the machined part (7), whereby the guiding recess (9), when the blank is arranged in the supporting device, is arranged to accommodate a projection arranged in a specified position on the supporting device.

5. Blank according to any of claims 2 to 4 c h a r a c t e r i s e d in that the blank has a readable code that specifies the characteristics of the blank.

6. Blank according to claim 5 c h a r a c t e r i s e d in that the part for firm attachment is cylindrical (5) and at its free end has a flat surface section (13) plus that the plane of the surface is arranged parallel with the centre axis (6) of the part for firm attachment.

7. Blank according to claim 5 c h a r a c t e r i s e d in that the code is expressed by specified geometric changes in shape on the blank.

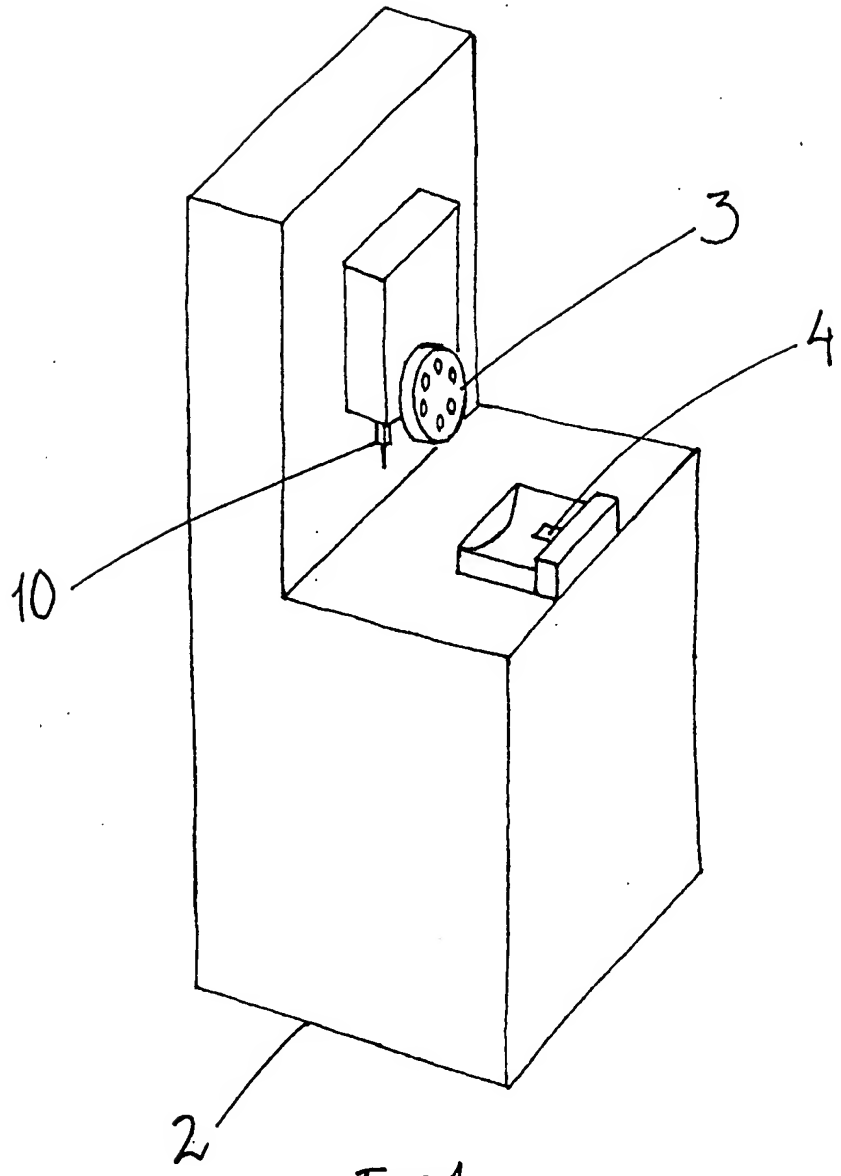

FIG 1

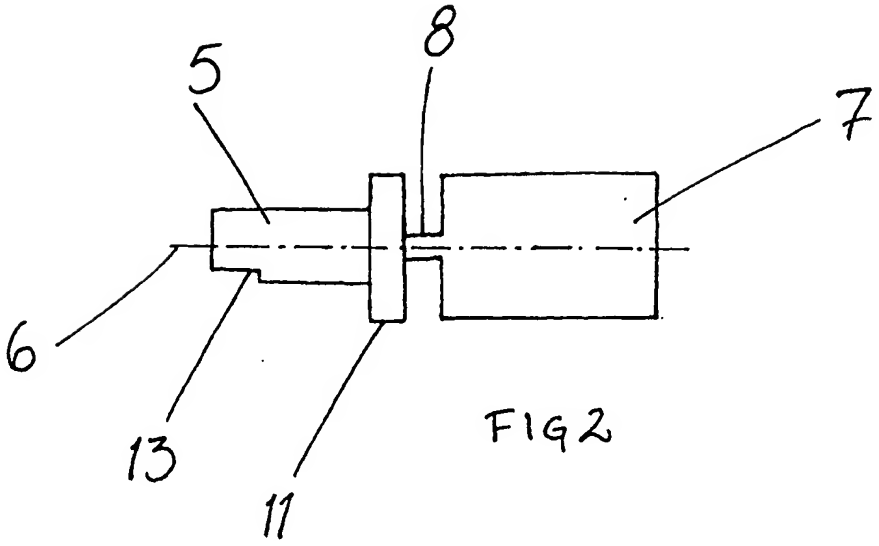

FIG2

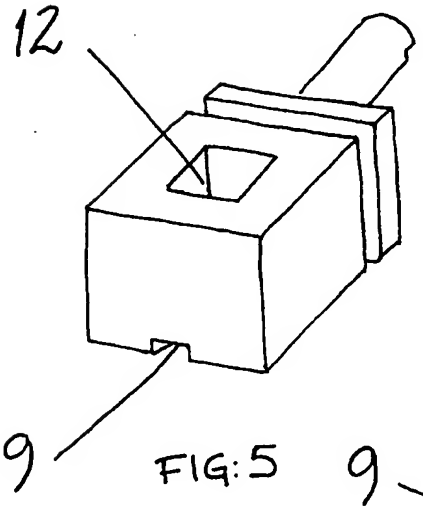

FIG:5

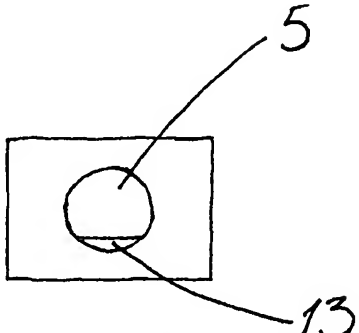

FIG3

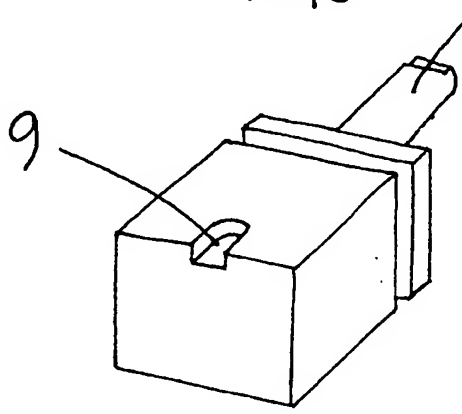

FIG4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 98/01660

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: A61C 13/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: A61C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9637163 A1 (SIEMENS AKTIENGESELLSCHAFT), 28 November 1996 (28.11.96) --	1-7
A	WO 9727818 A1 (CHOPLIN, DOMINIQUE), 7 August 1997 (07.08.97) --	1-7

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INTERNATIONAL SEARCH REPORT

Information on patent family members

01/12/98

International application No.
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9637163 A1	28/11/96	DE 19518702 A	28/11/96
WO 9727818 A1	07/08/97	AU 1549897 A	22/08/97
		AU 6934896 A	27/03/97
		EP 0865477 A	23/09/98
		FR 2744012 A,B	01/08/97